FIRE FUNDAMENTALS
05179

FOREST FIRE FIGHTING FUNDAMENTALS

FOR USE BY FIRE PROTECTION AGENCIES AND COOPERATORS ENGAGED IN FIRE FIGHTING ON FOREST AND OTHER WILD LAND

UNITED STATES
DEPARTMENT OF AGRICULTURE
FOREST SERVICE

STATE OF CALIFORNIA
DIVISION OF FORESTRY
DEPARTMENT, NATURAL RESOURCES

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F O R E W O R D

We have inherited a tremendous responsibility: the priceless treasures of natural resources of this Nation have been entrusted to our care. As Nature's abundance sustained our forefathers, it sustains us; that abundance will and must be available for our children and their children.

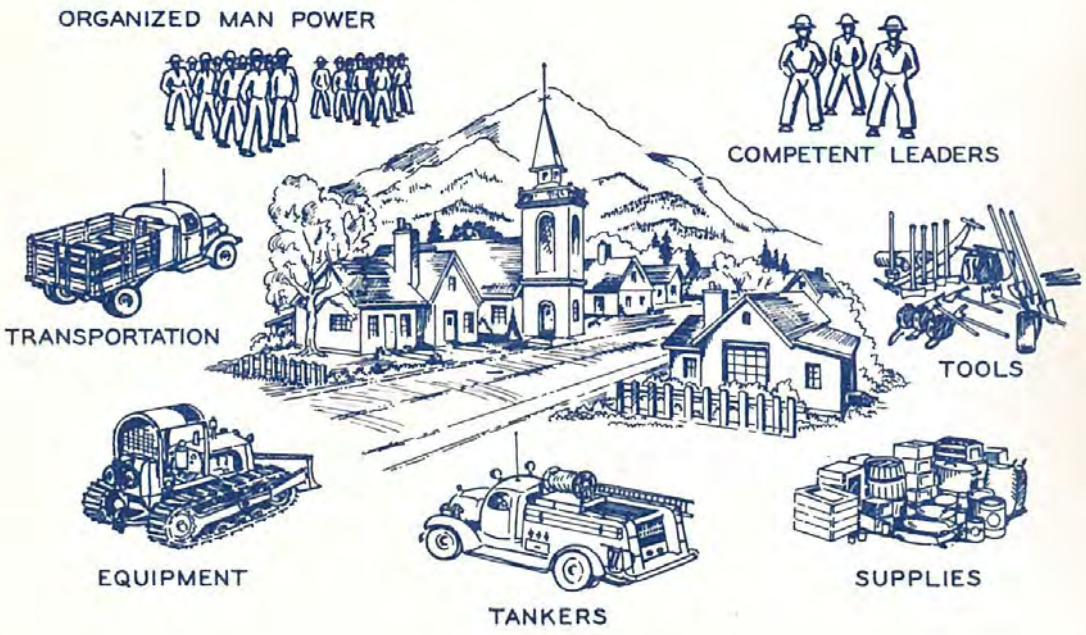
To keep these natural riches abundant, we must zealously guard them from all destructive agents. The foremost among these agents is fire - man's best servant but worst enemy!

Let us not have a scorched earth policy in America. Instead let us use and preserve our lands to raise food and fiber for our citizens, soldiers, and our coming generations. Let us not turn loose this all-consuming fire to destroy our resources. Let all forces of church, school, civic clubs, industry, labor, and government be organized and trained to prevent and suppress wildland fires.

I N T R O D U C T I O N

THE CITIZEN'S PART IN WILDLAND FIRE PROTECTION

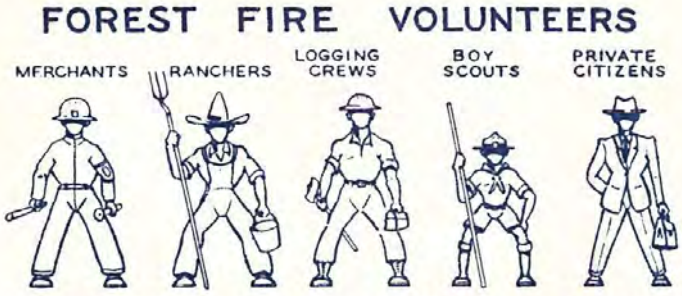
The U. S. Forest Service, the U. S. Park Service, State Forestry Divisions, the U. S. Bureau of Land Management, County Forest and Fire Departments, Fire Protection Associations, and Rural Fire Protection Districts have competent leaders, supplies, tools, equipment, and limited fire suppression crews in readiness for the normal fire season. You know these organizations and have come to depend upon them for the control of wildland (forest or timber, brush and grassland) fires.



During critical periods the citizens have been of great aid to these agencies. Their actions have been responsible for a large measure of the success experienced in the suppression of wildland fires in America. There is today far clearer knowledge of how to better prepare for, and how to do, the tasks of fire suppression.

Fires started by misguided people can swiftly overload the firefighting resources of the organized protection agencies. If a great number of fires were started within a short period of time, there would not be enough regular crews to send one to each fire immediately. Should this situation arise, it will become necessary for each one of us alone, or with a local group, to add our strength to the firefighting effort. By our individual and cooperative action disasters can be averted. Every small blaze is a potential disaster.

This pamphlet has been prepared by the California State Division of Forestry and the U. S. Forest Service. It sets forth, for our guidance and information, the many principles involved, the tools used, and the most common and accepted methods employed in the suppression of wildland fires. This is for the firefighter, volunteer, rancher, logger, sawmill worker, and Boy Scout. It is for all who are interested and concerned with the protection of the forest, watershed, and rangelands that are so vital to the continued well-being of the individual, the community, the State, and the Nation.



AIR
FIRE
FUEL

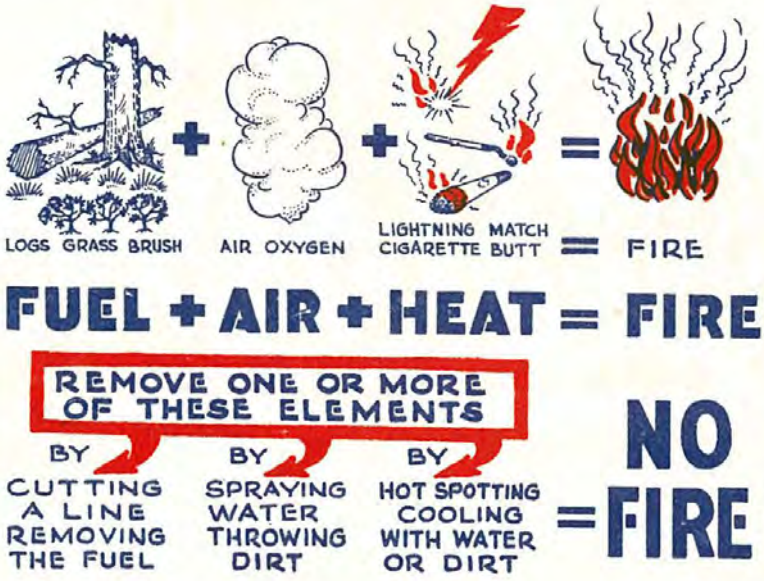
BASIC KNOWLEDGE NEEDED BY EVERY FIREFIGHTER

Successful firefighting is based upon the knowledge of why a fire burns and what makes it spread. An understanding of the fundamentals discussed below will help you to do a better job.

WHY A FIRE BURNS

When enough heat is applied to a fuel, the result is fire. This happens because fire is simply a rapid chemical combination of fuel, heat, and air. Heat is necessary to begin the reaction. Once started fire produces its own life-giving heat. Wildland fires originate from sparks and embers from cigarettes, trash fires, car, truck and tractor exhausts, lightning, etc.

Fire cannot exist in the absence of any one of the following three elements: heat, fuel, or air. The basic principle of fire suppression is to remove one or more of these elements in the quickest and most effective manner. There is no other way!


LOGS GRASS BRUSH
AIR OXYGEN
LIGHTNING MATCH CIGARETTE BUTT
= FIRE
FUEL + AIR + HEAT = FIRE
REMOVE ONE OR MORE OF THESE ELEMENTS
BY CUTTING A LINE REMOVING THE FUEL
BY SPRAYING WATER THROWING DIRT
BY HOT SPOTTING COOLING WITH WATER OR DIRT
= NO FIRE

WHY A FIRE SPREADS

You can be effective as a firefighter if you know what makes a fire behave as it does.

Why does a fire burn fast? Why does it slow down? Why does it burn so intensely at times? Why does it burn in one direction and not another? Just what is the cause of this varying behavior?

There are many causes and reasons for fires acting as they do; but, the primary factors that influence the spread of fire are: fuel, weather, and slope.

FUEL

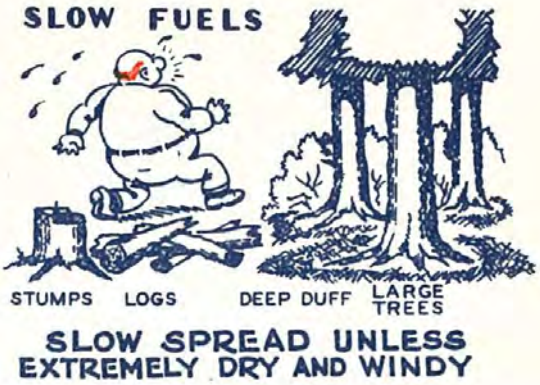
WEATHER

SLOPE

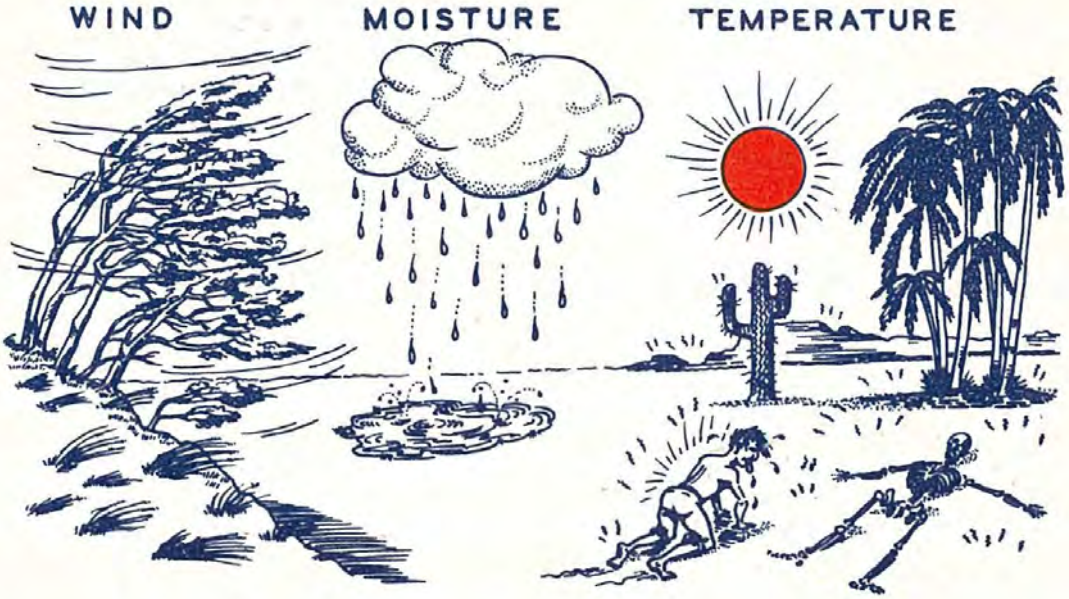
FUELS are commonly divided into two main groups:

1. Light or fast burning fuels such as dry grass, dead leaves and tree needles, brush, and small trees. Light fuels cause rapid spread of fire and serve as kindling for heavier fuels. Some green fuels such as tree needles, sage, chamise, ceanothus, and other brush types have a high oil content and are fast burning when they are not in the active growing stage.

2. Heavy or slow burning fuels such as logs, stumps, branchwood, and deep duff (the top soil or partly decayed leaves and tree needles found under dense stands of brush or trees). Heavy fuels burn readily and throw off large volumes of heat when dry.



WEATHER factors with which you as a firefighter will be concerned are: wind, moisture, and temperature.



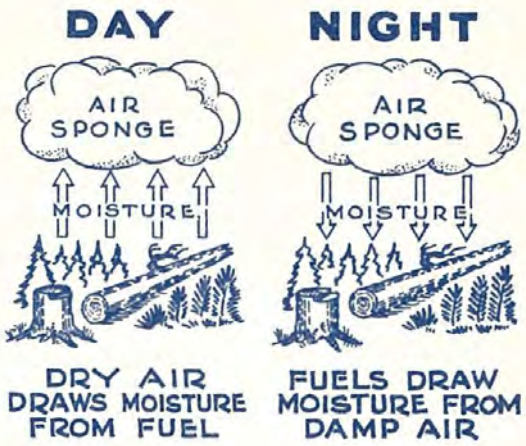
1. WIND

The stronger the wind, the faster the spread of the fire. This is true because wind brings an additional supply of air to the fire, flattens the flame which preheats the fuel ahead, and causes spot fires by blowing sparks and embers ahead of the main fire into new fuel.

Fire itself causes local air currents that add to the effect of the prevailing wind on fire spread. The air above the flames becomes heated and rises. This results in fresh air rushing in to help the burning. Generally, the least wind occurs during the morning period from 4 A.M. to 7 A.M. Under normal conditions heat from the sun warms the ground at lower elevations and causes the heating of the air next to the ground. This causes air currents to flow up the canyons and slopes during the day. Upon becoming cooler at the higher elevations during the evening and night periods, the air currents reverse their direction and flow down the canyons and slopes. The direction of canyon and slope wind-flow should be remembered when planning the attack on a fire - - - - <u>normally</u> - - - - wind flows up the canyon by day and down by night!

2. MOISTURE

Moisture in the form of water vapor is always present in the air. The amount of moisture that is in the air affects the amount that is in the fuel. It is absorbed from wetter fuels by the air and from the air by drier fuels. The moisture content of fuels is an important consideration in firefighting since wet and most green fuels will not burn freely. Air is usually drier during the day than it is at night. Fires, then, burn more slowly at night, under normal circumstances, because moisture is absorbed by the fuels from the damp night air.



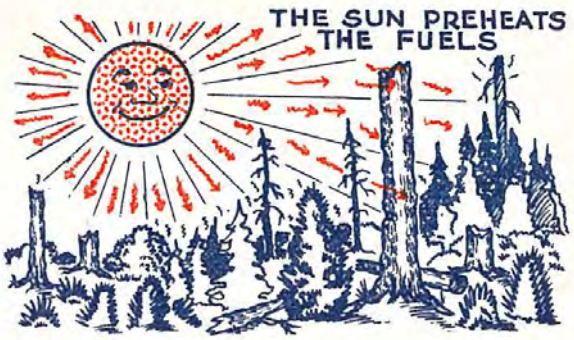
Absorption of moisture by the fuels, down slope winds, lower temperatures, and other day-night weather differences generally aid the firefighter at night. This explains why a fire burns out of control in the afternoon and yet may be handled by the same crew at night.

Every effort should be made to completely surround and permanently stop (to control) a fire before bad burning conditions build up the following day.

This does not mean that no attempt should be made to suppress fires during the day. Most fires are controlled during the day. If a fire cannot be controlled during the day an all-out effort must be made at night.

3. TEMPERATURE

Air temperature affects firefighting. Fuels pre-heated by the sun burn more rapidly than do cold fuels. The temperature of the ground also affects the movement of air currents, as explained previously.



Not only does temperature affect fuels and air movements but there is a very direct effect upon the firefighters themselves.

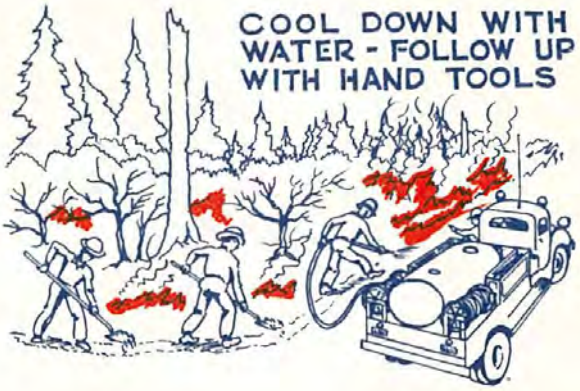
SLOPE greatly affects the spread of fire in two ways: by preheating and draft. A fire will run faster uphill than it will downhill if the wind is not strong enough to otherwise influence the spread. On the uphill side the flames are closer to the fuel. This causes preheating and faster ignition. Heat rises along the slope causing a draft which further increases the rate of spread.

On steep slopes burning chunks of fuel may roll downhill starting new fires.

FIRE EXTINGUISHING PRACTICES

There are a variety of ways of extinguishing a fire. Your choice of methods, or combination of them, will depend upon your size-up of the situation and the men, tools, and equipment available for the job.

USE OF WATER



If properly applied and available, water is the best and fastest tool with which to stop fire. It is supplied by tank trucks, spray rigs, back pack pumps, or, of course, buckets and cans. On fires burning in grass, ground litter (dead leaves, tree needles, twigs), and low brush, the tank truck or spray rig moves slowly along the fire edge. In country where water carrying vehicles cannot operate, men with back pack pumps follow the same course of action.

The efficient application of water is made by directing the spray parallel to the fire edge. To conserve as much water as possible shut off its flow at every opportunity. You will seldom have enough water to completely extinguish a fire. Water, then, is usually used only to cool a fire and stop its spread. Action is not completed until fuel is removed from the path of a fire. This is accomplished by the construction of a trench, or fire line, down to mineral soil along your water control line.

USE OF DIRT

Like water, dirt will help cool and smother the fire. The dirt should be thrown in a swinging motion so as to scatter it in a thin layer at the base of the flames along the fire edge. The best results are obtained by fast and continual action. If digging is tough, a couple of men should keep a stock-pile stacked up for the dirt thrower.

Dirt is an effective tool in checking flames in snags, stump, or brush patches.

BUT

DO NOT

CONSIDER

HOT MATERIAL

AS SAFE

WHEN

COVERED

WITH

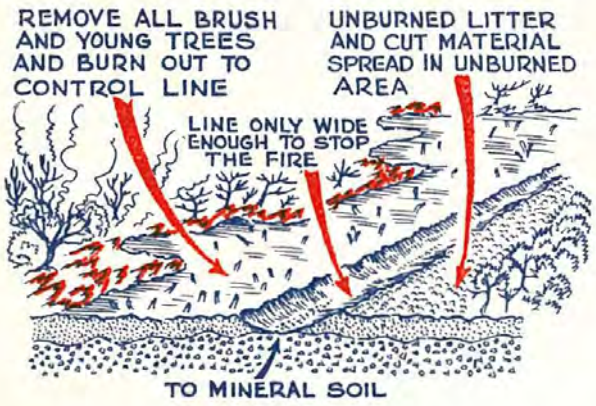
DIRT.

Fire may hold under the soil for a long time and then creep out or blaze up. Buried fire should be uncovered and extinguished as soon as possible after the spread of the fire is checked.

USE OF GREEN BOUGH OR GUNNY SACK

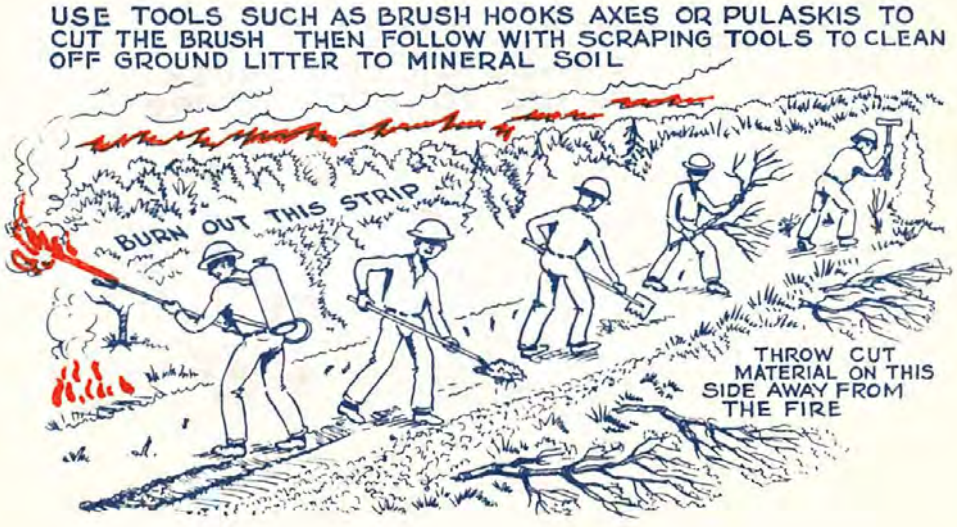
Green boughs or wet gunny sacks are used to good advantage in stopping fires that are burning in grass or low brush. This method is used to cool the edge of a fire in advance of fire-line construction. The swinging action of the bough or sack is directed toward the fire so that embers and sparks are whipped into the burned rather than unburned area.

USE OF FIRE LINE

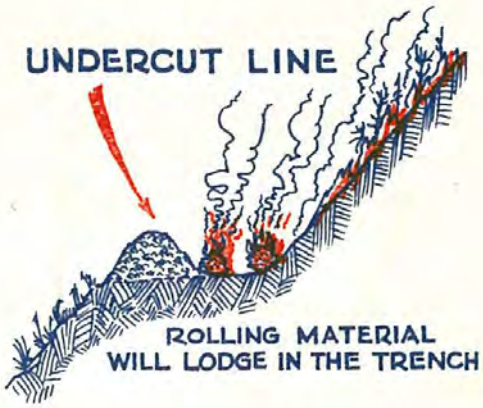

REMOVE ALL BRUSH AND YOUNG TREES AND BURN OUT TO CONTROL LINE
UNBURNED LITTER AND CUT MATERIAL SPREAD IN UNBURNED AREA
LINE ONLY WIDE ENOUGH TO STOP THE FIRE
TO MINERAL SOIL

A fire line is constructed for two purposes: (1) to make a safe strip from which to start burning out the intervening material between the line and the fire edge, and (2) to isolate the burned area from the unburned area.

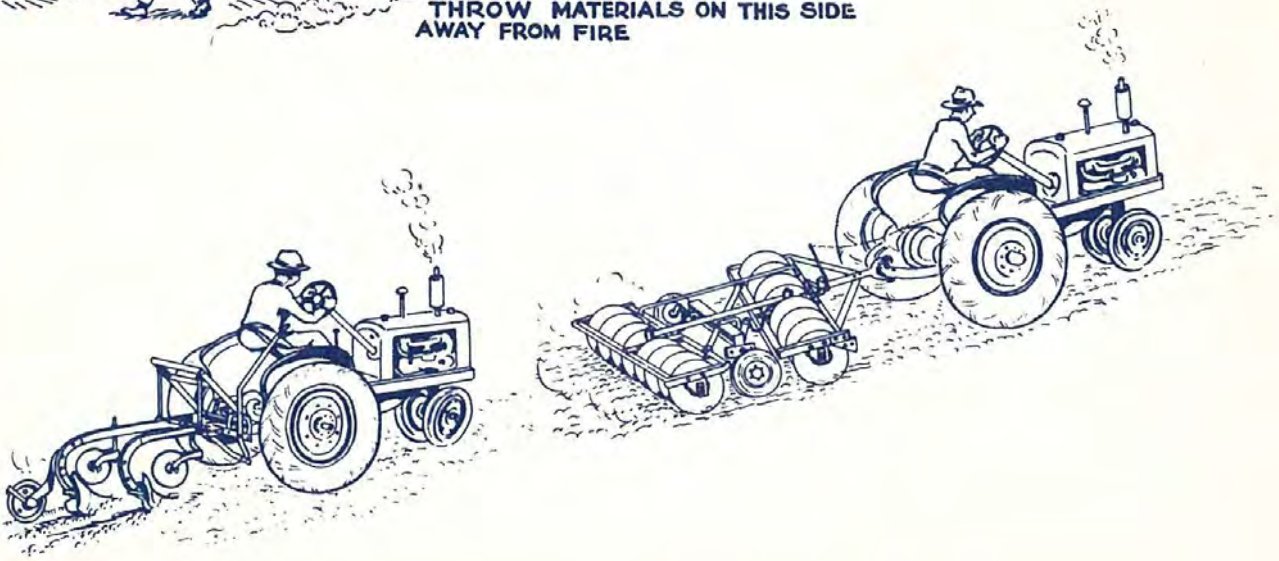
In fuels such as grass, tree needles, leaves, etc., a fire line is built with a shovel, hoe, rake, or other scraping tool. Unburned materials should be scattered on the side of the line away from the fire to avoid adding fuel to the fire. Materials that are partly in the fire or are charred should be thrown into the fire. Fuels of brush or young trees are removed by cutting tools such as brush hooks, axes, or pulaskis. After they have been removed it is necessary to follow up with scraping tools along the line to clear off the duff to mineral soil. It is important that any intervening strip of unburned vegetation and duff between the fire line and the edge of the fire be completely burned. This practice is called "burning-out" or "firing out."


USE TOOLS SUCH AS BRUSH HOOKS AXES OR PULASKIS TO CUT THE BRUSH THEN FOLLOW WITH SCRAPING TOOLS TO CLEAN OFF GROUND LITTER TO MINERAL SOIL
BURN OUT THIS STRIP
THROW CUT MATERIAL ON THIS SIDE AWAY FROM THE FIRE

On the downhill side of a fire the lines are trenched in such a manner that rolling material from the burning area will be caught in the trench and cannot cross into unburned area. The depth and width of this trench will depend on the steepness of the slope and the size and nature of the materials (logs, limbs, pine cones, etc.) above the line.



Tractors equipped with a bulldozer, plows and discs are effective tools in fire line construction. The same precautions are observed with a machine as with a hand constructed line. Burning material disturbed by a bulldozer blade must be shoved onto the fire side of the line.



CONSIDER - LIFE HAZARDS INVOLVED
IMPROVEMENTS AT STAKE
FIRE POTENTIAL

DECIDE - WHAT CAN BE DONE WITH AVAILABLE -
MEN
TOOLS
EQUIPMENT

ATTACK - DIRECT -
HOT SPOTTING
COLD TRAILING
SNAG REMOVAL
INDIRECT -

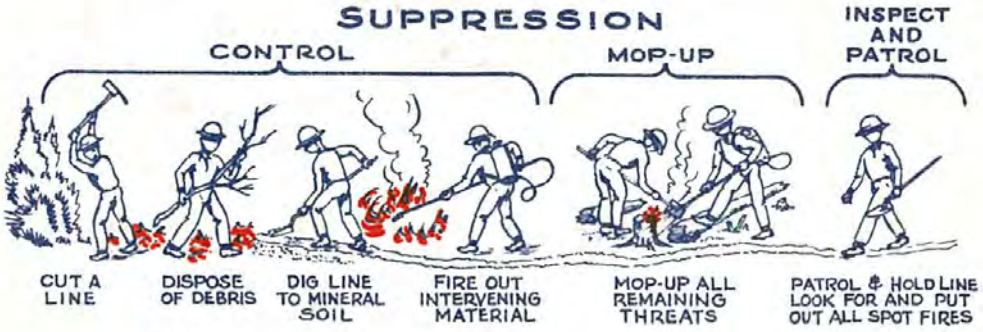
REMEMBER --- Fire cannot exist in the absence of heat or air or fuel. The job is to decide how these can be removed or their effects reduced in the quickest and most effective manner. After this decision is made it is necessary to determine what tools and methods should be used and how they should be applied. These decisions are a part of the plan for attack.

Fires are suppressed in three steps or stages:

Control the fire; stopping the spread of the fire

Mop up the fire; extinguishing all burning materials

Patrol and inspect the fire; looking for and extinguishing all danger spots during and after mop-up.



These three steps of action should follow each other closely. The first objective is to stop the spread. On a fire, however, mopping up and patrol and inspection may be taking place in one section while control work is beginning on another. This is usually possible when sufficient men are available to stop the spread and when the rate of spread generally is not very great.

CONTROLLING THE FIRE

SIZE-UP AND FIRST ATTACK

THINK OF THESE 5
WIND DIRECTION?
TYPE OF FUEL BURNING?
TYPE OF FUEL IN PATH OF THE FIRE?
SAFETY OF MEN?
SLOPE AND NATURAL BREAKS?

It is important for the first crew leader or man arriving on a fire to immediately size it up. As fast as possible he should get into a position where he can see the entire edge of a fire. This may require walking or scouting entirely around a fire. He should consider the five factors that influence what a fire is doing and why and how its behavior may change. This size-up is a continuing process until the fire is under control.

In the size-up decide where the fire is most likely to spread into heavy cover or start up slope. These are the things that will result in an increase of heat or a rapid rate of spread. Look for spot fires and decide if they need attention before you start action on the main body of the fire.

DECIDE IF SPOT FIRES NEED ACTION FIRST

Consider buildings, power and telephone lines, bridges, grain fields, and other improvements located in the probable path of the fire. Exert every effort to save somebody's home; but, do not jeopardize the control action on the fire to save something that can be replaced or is of little relative value compared to the potential damage the fire could cause if allowed to go unchecked. Consider also, at this time, the safety of yourself and the men with whom you are working. In your plan of action do not allow your crew or yourself to get trapped by the fire.

IMPROVEMENTS VS THE FIRE

ATTACK METHODS

For the sake of simplicity this handbook will consider all methods of attacking a fire under two titles: the DIRECT ATTACK and the INDIRECT ATTACK. The description of these methods is followed by guide lines for you to study as an aid in deciding which method to use.

THE DIRECT ATTACK:

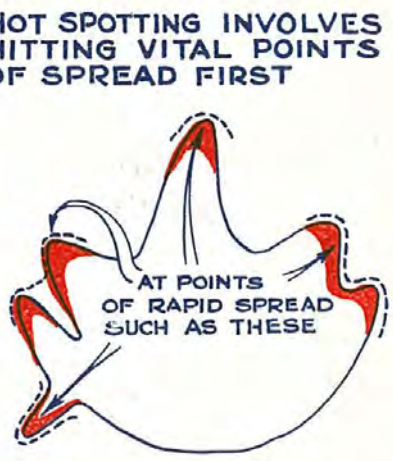
The practices used in direct attack are those described in the previous section entitled "Fire Extinguishing Practices."

In a direct attack the effort is put directly on or immediately adjacent to the edge of a fire. You either "hit the head" (point of most rapid spread) or start at the rear and work forward on both sides (flanks) at the fire edge and thus pinch out and control the head.

ATTACK FIRST WHERE IT IS MOST LIKELY TO GET AWAY

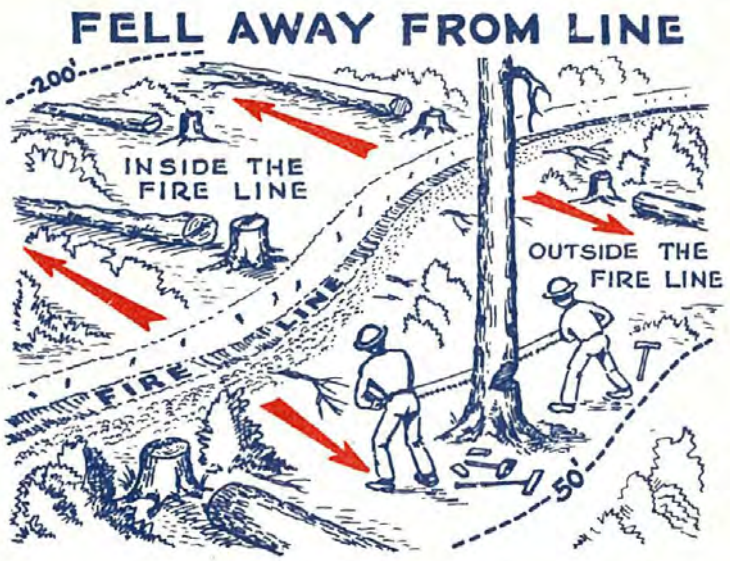
IN DENSE BRUSH OR TIMBER IF FIRE TOO HOT TO ATTACK HEAD FLANKING ACTION TAKEN FROM SAFETY VIEW POINT

Hotspotting You may arrive at a fire that is too large for you to control without more help. The most valuable action that you can take is to work directly on the most rapidly spreading points of the fire and to endeavor to hold these points until more help arrives. Even if you succeed in only checking the spread at one or two points you will have made the final control job smaller -- which is important. This work is usually done by a small experienced crew in advance of the main crew on large fires.



Cold Trailing is another important variation of the direct attack method. Often a fire dies down leaving a quiet edge of fire which is not spreading and which may be out in places. It is necessary to work right on the fire edge at such stretches. Build a narrow line and throw all hot stuff along the line into the burned area. Do not take chances by leaving a section unworked because it looks "out." Feel out the ashes with an ungloved hand to make certain that there is no hot stuff buried.

Snag Removal is necessary where snags exist adjacent to the fire line, with both the direct and indirect attack. Old snags are dry and punkish, and in a general state of disintegration. One small spark will easily set them ablaze. They, in turn, will shower the countryside with sparks. Snags are dangerous. Follow the instructions outlined below for both methods of attack.



As operations proceed cut down snags standing adjacent to and on both sides of the control line:

(1) For a distance of 200 to 300 feet on the fire side of the line. The distance to which snags are to be felled increases with the height of the snags, their elevation above the fire line level, and the degree to which they are exposed to wind.

(2) For a distance of 50 feet on the opposite side of the line.

Fires have been lost because snags have not been felled on both sides of the line. When time will not allow snags to be felled before a backfire (an indirect attack function) is started you should fall them as soon afterward as is possible.

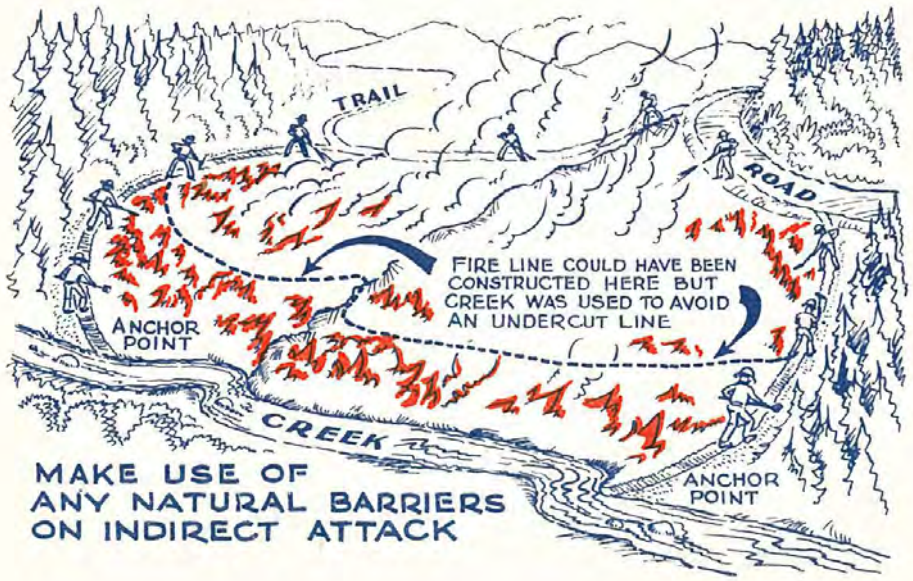
If speed is essential or if snags are so situated that falling is not possible, the fuel around the base of each snag inside the line, to the distances back of the line indicated on the preceding page, is to be cleared and scattered. This is called "ringing" a snag.

Watch both sides of the line, whether a direct or indirect control line, for sparks that cross to start spot fires. Place men at high strategic points to be on the lookout for spot fires and fast running fingers from the main fire. Be prepared to put out spot fires before they get large.

THE INDIRECT ATTACK:

Under the indirect method of attack the control line is located along favorable breaks in the topography or natural fire-breaks and the area between the fire edge and the control line is backfired out when burning conditions are favorable and when all crews have been notified.

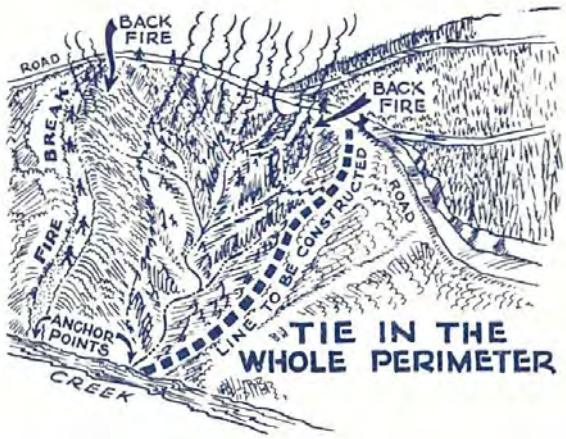
Many times it is impossible or impracticable to make a direct attack on a fire when it is burning rapidly or crowning in heavy fuels. Where fires are burning downhill on very steep slopes, rolling materials sometimes make it impossible to check the spread of the fire. Safety to you and other fire-fighters is a big consideration when deciding whether a direct or indirect attack should be made.


TRAIL
ROAD
FIRE LINE COULD HAVE BEEN CONSTRUCTED HERE BUT CREEK WAS USED TO AVOID AN UNDERCUT LINE
ANCHOR POINT
CREEK
ANCHOR POINT
MAKE USE OF ANY NATURAL BARRIERS ON INDIRECT ATTACK

There are several variations in the use of the indirect attack method.

(1) Normal Use of the Indirect Attack Method.

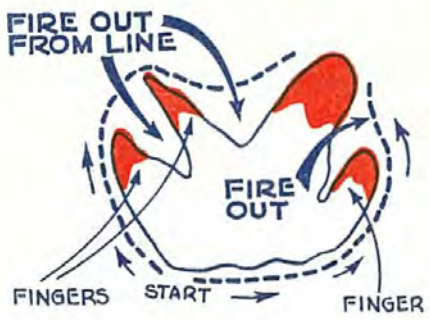
Take advantage of all existing breaks such as roads, trails, creeks, and other barriers when using the indirect attack. Where existing breaks do not completely surround the fire it is necessary to construct lines to complete the control line. The width of these lines depends upon the type and nature of the vegetation, the wind direction and velocity, and the slope on which the fire will come into them. Whether made by hand or machine the same line practices are to be followed as outlined under "Use of Fire Line."

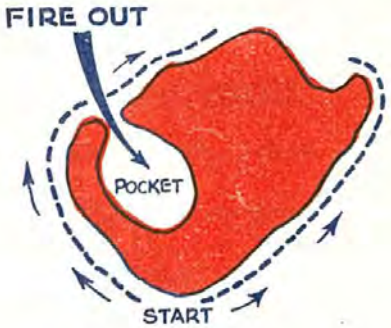


A change in burning conditions may enable you to change your attack method and by direct attack attain control long before you could complete your planned indirect control line. In such cases, a change in attack method to fit the current condition is the safest and wisest action to take. Such changes are most likely to occur during the night period. A new plan of action to fit the changed fire condition will insure earlier control and reduce the burned area.

(2) Combined Use of the Indirect Attack With the Direct Attack Method

When manpower is lacking or speed is necessary, deviate from a direct to an indirect attack by building a line between the tips of two or more fingers of fire that have unburned areas between them. The unburned areas are fired out from these lines.





Do not attempt to follow the fire edge in a direct attack where there are large indentations or pockets that have not as yet burned. Change to an indirect attack as described above and fire out the pockets.

(3) Extreme Use of the Indirect Attack - the Backfire

When a fire is spreading too fast to be handled by the direct attack method, is too dangerous to fight close, or is of such a nature that the available manpower is not able to catch it with the direct attack, then indirect attack by the backfire method is justified.

How to Backfire

After the control lines are established at strategic places in advance of the fire, the backfire is started. These control lines must be located on roads, ridges, creeks, or other existing breaks, or are specially constructed when necessary, with the thought in mind that a backfire is to be started from them. The lines are to be as straight as is possible and in such a

location (considering draft, wind, slope, fuel, etc.) that a good burn will be safely achieved, insuring control of the main fire.

The Purpose of a "Backfire"

Firing Out the edge of a control line is a method of widening the control line and of cleaning up unburned pockets or segments of land extending to the line from the fire edge. Burning out the intervening strip between the fire line and fire edge is for the safety and security of the line. Both of these procedures are used on small strips or larger areas abutting into the control line. Backfiring applies these methods in a more extreme way to control the fire. It is fighting fire with fire. It is the main tool with which the fire is stopped in the extreme use of the indirect method of attack.

Backfiring is a tricky and dangerous operation to be used only as last resort and by experienced fire fighters. If it is deemed absolutely necessary to use this method to control the fire the following points should be observed:

(a) Start backfiring on the highest point of the line to be fired. Work downhill while setting it.

(b) Tie in both ends of the line to be backfired, either to an area that has already been burned or to a line that is being utilized in the control operations. You must have an anchor point.

(c) Backfire slowly enough to insure ability to retain control on the entire line burned.

(d) Backfire in such a manner that men working on direct attack will not be jeopardized.

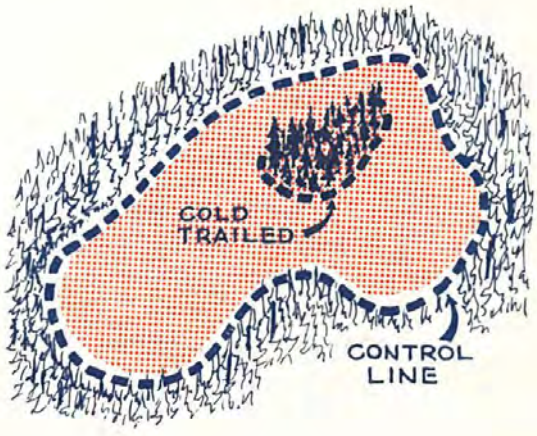
(e) Avoid the concentration of men in mountain saddles. They will be in danger if the backfire comes back at them in partially burned fuel.

(f) Fast running fingers of fire, if headed towards line not yet backfired, may necessitate short stretches of advance firing to prevent the fire from jumping the line. These are called buffer fires.

(g) Use the most efficient type of burner or torch in setting a backfire. The "Orchard Torch," the "Hauck Torch," and the fusee are in common use. The rake and wire broom tools are used to good advantage to drag burning material along the ground and start backfires in grass or tree needle country.

(h) Burn clean all vegetation. Either cut out or cold trail all islands, peninsulas or brush that do not burn.

(i) Start backfiring when the time is right slightly below the top of a hill or ridge and on the opposite side from the main fire. Do not do this on slopes steeper than 20% since deeply cut lines would be required to hold hot rolling fuel. On slopes steeper than 20% back up to the ridge top, or, to where the slope is less than 20%, the draft from the main fire will cause a suction effect on the backfire, insuring a good burn.



Guide Lines for the Application of Attack Methods:

The initial and continual size-up determines what method of attack is to be made on any part of all of a fire. The foregoing attack principles apply to any timber, brush, or grass fire regardless of where it is or what it is doing. An on-the-ground decision must be made as to what course of action is to be taken for each particular situation. The decision is the Fire Boss' responsibility; the decision of the boss is the subordinate's course of action.

Guide Lines: (1) Use the direct attack method immediately and completely around small or slow spreading fires.

THE DIRECT ATTACK METHOD
PRO
NO CHANCE FOR FIRE TO GAIN GREATER MOMENTUM OR SIZE
I SMELL SMOKE
E-OW-O-O-O
ELIMINATES DANGER OF FIRE CROWNING.
ELIMINATES THE UNCERTAIN ELEMENTS IN BACKFIRING
SAFEST PLACE TO WORK CAN ESCAPE INTO BURNED AREA
CON
WHERE AM I?
LONGER FIRE LINE
AND THEREFORE
MORE IRREGULAR
MEN WORK IN HEAT & SMOKE
CREWS SPREAD SPARKS INTO UNBURNED AREA LATER FLAREUPS
MORE MOP-UP

(2) Start at the rear of fast running fires with a direct attack and continue the action on the flanks until the opportunity arises to cut directly across the head of the fires. This system has the following advantages:

(a) Burned area is left behind into which you may go when danger threatens,

(b) Advantage is taken of all stretches where the fire is partially or completely out,

(c) Spread of fire is limited on three sides (rear and flanks) before you finally stop the head, and

(d) You do not have to contend with the dangerous and tricky elements of backfiring.

THE INDIRECT ATTACK METHOD
PRO
MEN ARE NOT WORKING IN THE HEAT & SMOKE
PERMITS TAKING ADVANTAGE OF FAVORABLE
BENCHES
TOPS OF RIDGES
BOTTOM OF SLOPES
ROADS
STREAMS
CHANGES IN COVER TYPE
ROCK SLIDES
SWAMPS
MEADOWS & CLEARINGS
TRAILS
CON
LOOK
LISTEN
STOP
SAFETY OF PERSONNEL FIRST CONSIDERATION
FAILS TO TAKE ADVANTAGE OF PORTIONS OF FIRE LINE THAT HAS GONE OUT BY ITS SELF
CAN MATERIALLY INCREASE THE AREA OF THE BURN
INTERVENING STRIP MAY NOT BURN OUT
MEN MUST BE HELD IN READINESS WHERE FIRE IS DUE TO BURN OUT BY ITS SELF

(3) Use the indirect attack where natural breaks can be utilized to good advantage

(a) Aided by <u>firing out</u> and <u>burning out the intervening strip</u>, or

(b) Letting the main fire back safely into the firebreaks.

(4) Use the indirect attack with a backfire only when guided by experience and expert leadership, or, under conditions of absolute necessity. If handled incorrectly, this method can jeopardize the control effort, utilize manpower inefficiently, endanger personnel safety, and threaten improvements. Handled correctly:

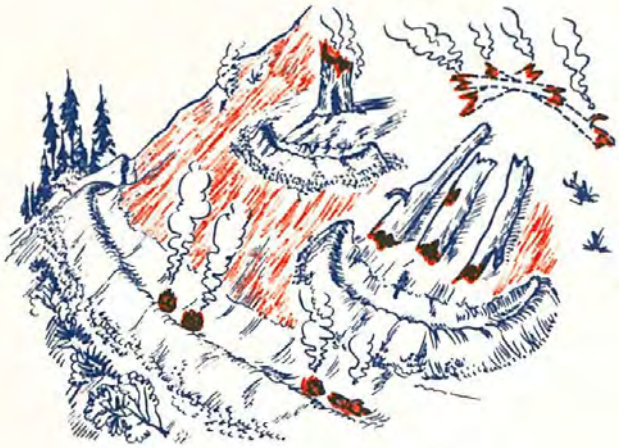
(a) Less manpower is required.

(b) Knowledge of the terrain can be utilized to locate an effective control line.

(c) The burned area is limited by a predetermined control line if the attack is successful. The ultimate burned area under a direct attack depends on when the head of a fire can be cut off.

M O P - U P

The mop-up state occurs after a fire, or any part of a fire, is controlled and before suppression work is reduced to a patrol and inspection. Mopping up consists of making a fire safe by extinguishing or removing burning and hazardous material, including snags along or near the control line. Specifically, the tasks to be accomplished are:



1. Extinguish all smoldering material along the fire edge after the spread has been stopped.
2. Put all rolling fuel into such a position (or trench below it) that it cannot roll across the line.
3. Spread, rather than bury, smoldering fuel that cannot be put out. If high winds are blowing sparks across the line, remove smoldering fuels to a safe distance within the line.

4. Bury burning fuels only when that is the fastest way of stopping spread or possibilities of sparks being blown across the line; but, uncover the fuels, and be certain that no fire is left in them before leaving the fire.
5. Allow fuel to burn if it will do so promptly and safely or, take steps to either extinguish or remove it.
6. Eliminate promptly, both inside and outside the line, all special threats such as snags, rotten logs, stumps, singed brush, and low hanging limbs of trees.

7. Look for and remove all burning roots that are near the line. Fires have escaped control creeping along burning roots that extended under the control line to fuels on the other side.

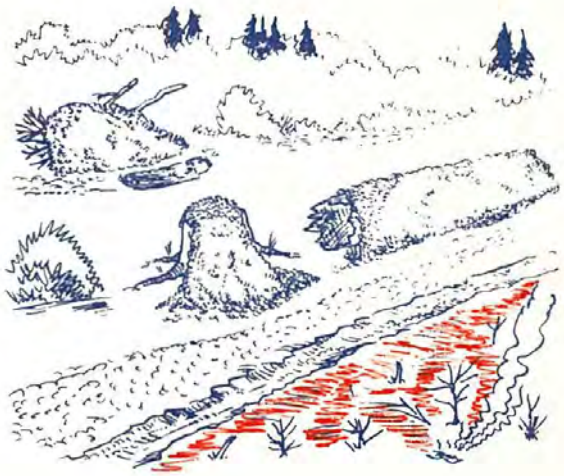
8. Extinguish all fire in the mop-up of small fires if the quantity of burning material is not so great as to make the task impractical.

9. Mop-up enough of the material adjacent to the line on large fires to be certain that fire cannot blow, spot, or roll over the control line under the worst possible condition.

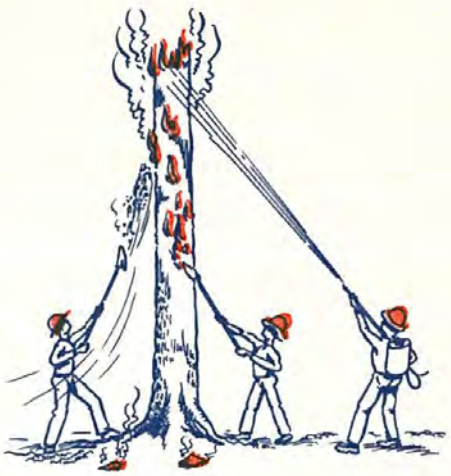
10. Search for smoldering spot fires across the line in front of the main head of the fire. Do this constantly during the whole life of the fire.

Chop fire out of heavy fuels and either scatter the small burning fragments or extinguish them with water or dirt. The lack of water or manpower may make it impracticable to extinguish all fuels burning near the line. In such cases it is better to scatter fuels well back into the burned area. This action decreases the possibility of fire spotting or blowing over the line from adjacent burning material.

Highly hazardous fuels consisting of punky logs and limbs, piles of slash, and other debris just outside a hot fire line are disposed of either by moving to a safe distance or by covering them with clean dirt (and checking them later). These are likely places where spot fires can start.



FALL INTO BURN
UPHILL OR DOWNHILL



APPLY DIRT OR
WATER TO BLAZE

A burning snag with fire above your reach is felled away from the fire line into the burn and in such a position that it will not slide or roll down hill. To provide a safe standing place for felling, shovel away or cover with dirt any hot material near the base of the snag. A falling crew consists of three men: two fallers and a safety man. The safety man watches for broken limbs or hot debris falling from the snag that would endanger the fallers. If a snag has a lean that does not permit it to be felled either up or down hill or into the burn, clear the fuel away from where it will fall, roll, or slide, then fell it. After it is down extinguish the fire it contains by scraping and chopping, or with water and dirt.

When a snag is burning at the base only:

1. Knock down the blaze with dirt or water,
2. Scrape out the burning part with axe or shovel,
3. Peel off loose bark as high as is possible,
4. Extinguish sparks in cracks with dirt or water, and
5. Scatter the small pieces removed from the snag in the burned-over area.
6. Larger pieces should be completely extinguished.
7. Clear and dig a safety fire line around the area in which burning material has rolled.

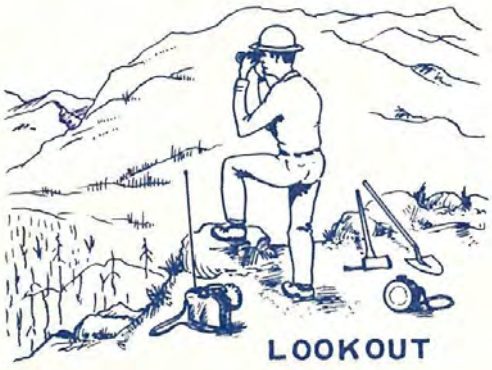
Patrol and inspection is necessary on all fires until the last spark is out. It may be said to consist of two jobs:

1. Line patrol and inspection
2. Lookout patrol and inspection

Line patrol and inspection is the act of watchfully working back and forth over a length of control line during or after line construction, equipped with proper tools to prevent breaks, discover and control spot fires, and mop-up whenever necessary.

LINE PATROL AND INSPECTION

Lookout patrol and inspection consists of constant watch over burned and unburned areas, from a point of vantage, to detect and report hazardous flare-ups or spot fires to work crews which are fully equipped to handle any trouble that might arise.



LOOKOUT

In fast burning fuel types patrol and inspection may be needed for only a few hours. This assumes that all fuels within the line, being of flashy (fast burning) nature, will completely burn, and, that any fire smoldering outside the line will show up quickly. In heavier fuel types patrol and inspection may continue for days or weeks.

One important job on patrol and inspection is to watch for and extinguish smoldering fuel in the burned-over area that may flash-up and throw sparks over the line. Another important objective is to keep constant watch on the unburned area to detect spot fires that may be smoldering in snags, punky logs, duff, etc. Temporary watch is put on hot and hazardous places along the line where it is not yet possible to begin mop-up. The man on patrol and inspection takes immediate action on any situation that requires it.

The importance of adequate patrol and inspection cannot be over-emphasized. To have a fire that has been controlled and apparently mopped-up start anew--- hours, days, or weeks later---can only be classed as someone's inexcusable failure.

B A S I C R U L E S

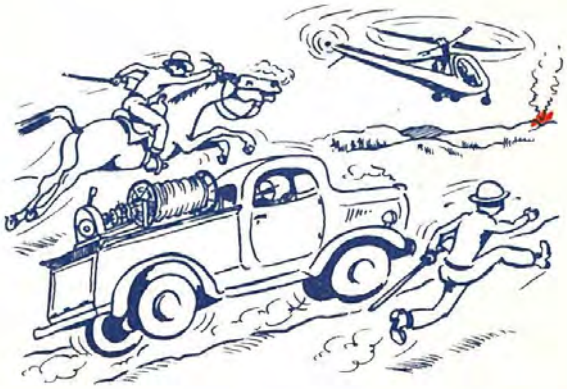
Study this handbook thoroughly. Refer to it when necessary. When you know what makes a fire burn and spread, what to do to stop a timber, brush, or grass fire, how to do it, and what to do it with, then .....

REMEMBER these rules upon which good forest fire control is based, and .....

BE PREPARED to act either as a one man crew or as part of an organized crew, as the situation may require.

1. FAST ATTACK

   Let's go! Get to every fire as fast as you can <u>with safety</u>.



2. AGGRESSIVE ACTION

   Hit it hard at the start.

   Keep it small.

3. CONTINUAL AND COMPLETE

   Stay with it until the fire is dead out!

A. S A F E T Y

Firefighting is a hazardous occupation. It will demand of you the highest efficiency, a sustained expenditure of energy, and your availability! You should take every precaution to prevent injury to yourself and others. The following points are stressed:

1. PHYSICAL FITNESS You know your own physical condition. Do not undertake physical exertion on a fire that you know is dangerous for you. However, do all that you can.
2. CLOTHING Wear sturdy serviceable clothing.

   Hat Any kind except a straw hat. A "hard" hat gives the greatest protection.

   Jacket One that is sturdy and warm enough for night use.

Trousers A tough pair with cuffless legs and baggy knees.

Shoes A heavy pair with 6 or 8 inch tops.

Socks A pair of medium heavy wool to prevent blisters. Carry an extra pair!

3. LEADERSHIP Never leave your leader or crew, except by instruction to do so, from your boss. Skilled leadership will save lives and prevent injury. The crew boss always has some escape route in mind, if needed.

4. TRANSPORTATION HAZARDS Be careful while riding to and from the fire in trucks. Always remain seated. Watch out for low hanging limbs and be sure that any tools carried in the vehicle are secured and so covered that they can injure no one.

5. TOOLS Be careful in handling axes and other sharp-edged tools. Carry them in your hand by your side and not over your shoulder. Keep a safe distance between yourself and other men while walking and working.

6. EXHAUSTION Do not work beyond the limits of your endurance. Excessive fatigue endangers your life.

7. HEAT PROSTRATION Use salt tablets to help you from being overcome by the heat.

10 FT.
APART WALKING OR WORKING IS SAFE PRACTICE
DON'T GO BEYOND THE LIMITS OF ENDURANCE
SALT TABLETS
DRINK SPARINGLY IF YOU'RE HOT AND SWEATY

8. BURNING AND FALLING OBJECTS Be constantly alert for the safety of yourself and others. Watch for flare-ups and for burning debris, rocks, etc., falling or rolling from above.

9. ROLLING OBJECTS Do not kick or start rocks or logs rolling that may endanger men working below you.

10. NIGHT WORK Use flashlights at night to prevent you from falling or stumbling.

KNOW WHERE THIS IS LOCATED

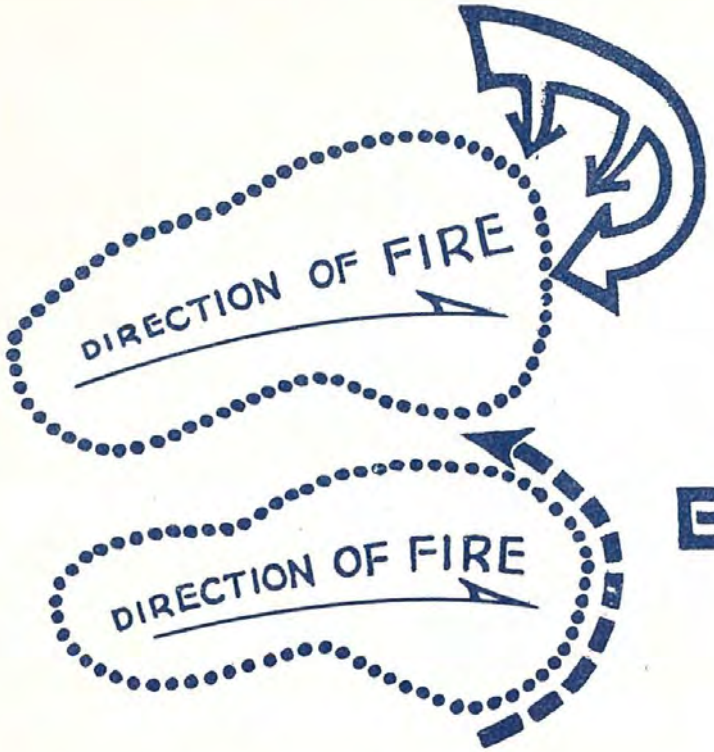
11. FIRST AID You or your leader should know where a First Aid Kit is located. Every organized industry or community crew should have a kit. Organized protection agencies carry kits on each fire vehicle.

12. DRINKING WATER Use canteens to carry water with you. Drink the water sparingly.

13. RUNNING FIRE Do not try to outrun a fire by going uphill. Head for the flanks! If possible get into a cooled off part of the burned-over area. A burned-over area is the safest place. Protect your face and cover your nose with a wet cloth if it is necessary to run through the burning fire edge.

14. CAUTION Use extreme caution in getting in front of a fire. Know what you are doing, why you are doing it, and what you are going to do to protect yourself if fire makes an unexpected run. Have escape routes in mind.

SMALL HOT FIRE



FIRST ATTACK

HEAD, IF SAFE, THROWING DIRT ON FLAMES TO COOL.

THEN ENCIRCLE

WITH LINE AT EDGE OF FIRE.

WHY

CORRALS FIRE WITH MINIMUM LINE AND MAXIMUM SPEED. MINIMIZES SPOT FIRE DANGER.

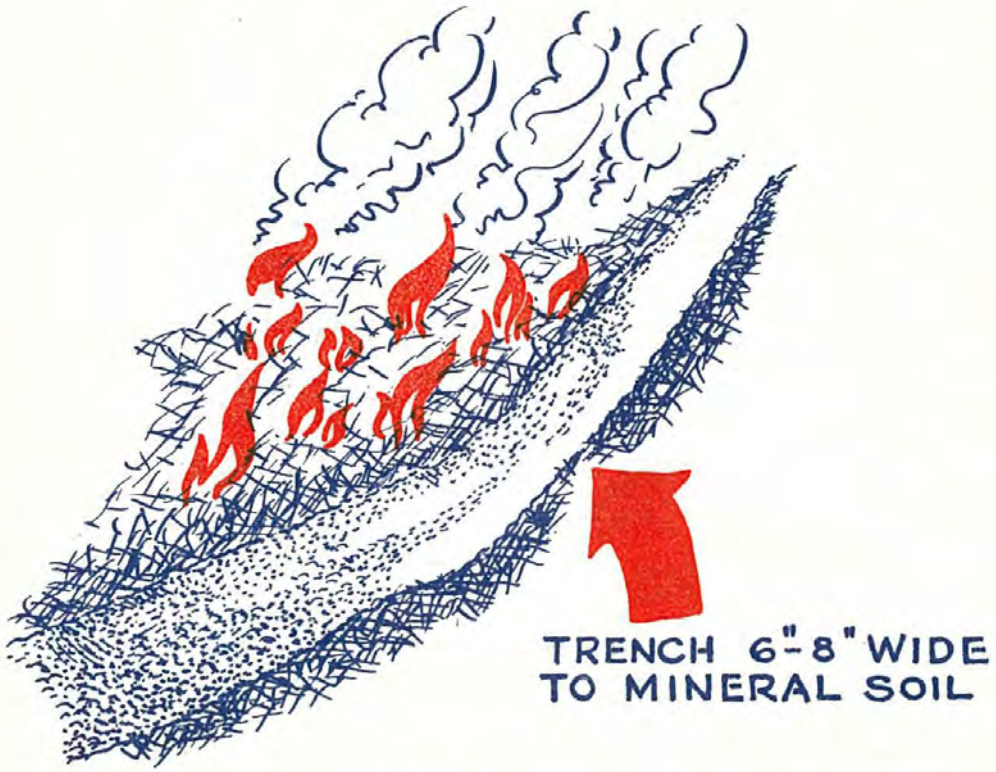
TIPS

DIRT IS OFTEN MORE EFFECTIVE THAN WATER.

DIRT APPLIED RAPIDLY IS MOST EFFECTIVE.

IF DIRT IS HARD TO OBTAIN, ACCUMULATE SMALL PILE AND APPLY RAPIDLY.

RAPID SPREADING FIRE IN NEEDLES, ETC.



ATTACK

1. USE SCRATCH LINE TO CHECK ADVANCING FIRE OR SMOTHER WITH DIRT OR WATER.
2. COMPLETE LINE AFTER RAPID SPREAD IS STOPPED, MAKING A SAFE LINE AT FIRE EDGE.

WHY

STOPPING SPREAD OF FIRE AND BUILDING SAFE FINAL LINE IN ONE OPERATION IS TOO SLOW; CANNOT KEEP PACE WITH SPREAD.

FIRE TOO BIG FOR FIRST ATTACK TO CONTROL

CONDITIONS

UNIFORM SPREAD, COVER, ETC.

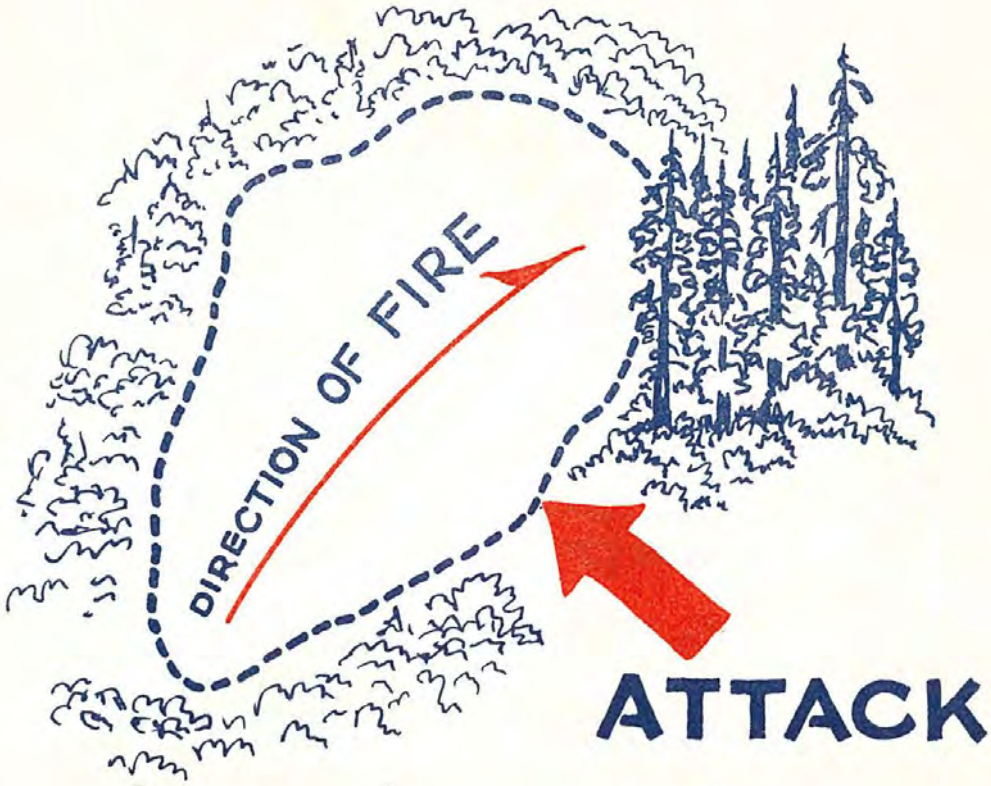
ATTACK

1. SCOUT FIRE TO HAVE INFORMATION AVAILABLE WHEN FOLLOWUP CREW ARRIVES.
2. STAY WITH FIRE.
3. BEGIN WORK AT REAR OF FIRE AND PROCEED ON REAR AND FLANKS UNTIL HELP ARRIVES.
4. ATTACK AT HIGH DANGER POINTS, IF FIRE CAN BE KEPT OUT OF WORSE FUELS SAFELY.

WHY

MAKE TIME AND EFFORT EFFECTIVE IN PARTIAL CONTROL, INSTEAD OF FUTILE EFFORTS TO HEAD FIRE.

FIRE NEAR HEAVY FUEL



FIRST

CONTROL EDGE OF FIRE NEAREST HEAVY FUEL.

WHY

TO PREVENT FIRE FROM GETTING INTO HEAVY FUELS AND OUT OF CONTROL. SAVES MORE MOP-UP WORK.

HOLDING FIRE TO ONE SLOPE

CONDITIONS

TOPOGRAPHY STEEP.
FIRE NEARING CREST OF RIDGE.
DANGER OF ROLLING MATERIAL CARRYING FIRE DOWN ON OTHER SIDE.

ACTION

1. ATTACK FIRST AT CREST.
2. LOCATE LOWER LINE HERE TO AVOID UNDERCUT LINE.

WHY

1. TO HOLD FIRE TO ONE SLOPE. IF FIRE PASSES CREST, BURNING PINE CONES AND OTHER FUEL CAPABLE OF CARRYING FIRE MAY ROLL DOWN OTHER SLOPE INTO UNBURNED AREA, CAUSING MORE FIRES.
2. CANYON BOTTOM ACTS AS A TRENCH AND SAVES EXCESS LABOR IN BUILDING TRENCH.

THREE LIGHTNING FIRES IN SAME GENERAL AREA

CONDITIONS

LIGHT PRECIPITATION WITH STORM. OTHER FIRES MAKE PROMPT FOLLOWUP UNLIKELY.

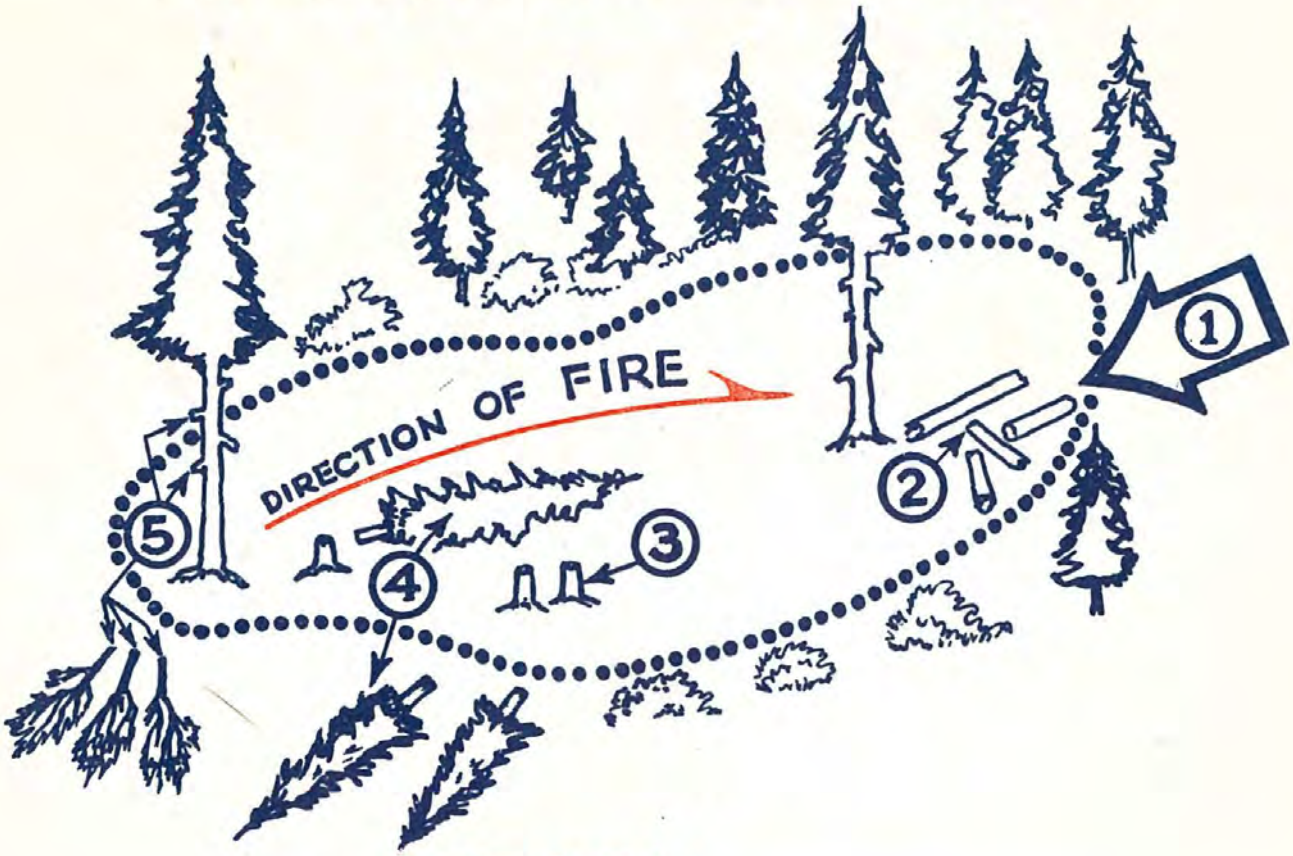
ATTACK

1. THREE MEN ASSIGNED.
2. GENERALLY, ALL MEN PUT CORRAL LINE AROUND ONE FIRE, THEN THE OTHERS, TO KEEP THEM FROM SPREADING.
3. THEN, COMPLETE CONTROL AND MOP-UP ON EACH FIRE AS SOON AS POSSIBLE.
4. ONE MAN REMAINS ON EACH FIRE UNTIL OUT.

WHY

SO NEITHER FIRE SPREADS TO LARGE SIZE AND TO COMPLETE JOB WITH ORIGINAL LABOR, AVOIDING NECESSITY OF FOLLOWUP.

TO PREVENT CROWNING



ATTACK

THE HOT HEAD

1. THROW DIRT AT BASE OF FIRE TO CUT DOWN HEAT AND PREVENT CROWNING.
2. SCATTER FUELS CAUSING HEAT.
3. REMOVE SMALL TREES THAT MAY CROWN, AND
4. THROW TREES, NOT BURNING, WELL OUTSIDE OF FIRE, OR IN BURNED-OUT AREAS.
5. REMOVE LOWER LIMBS ON LARGE TREES, THAT MAY CAUSE CROWNING, TO SAFE AREAS

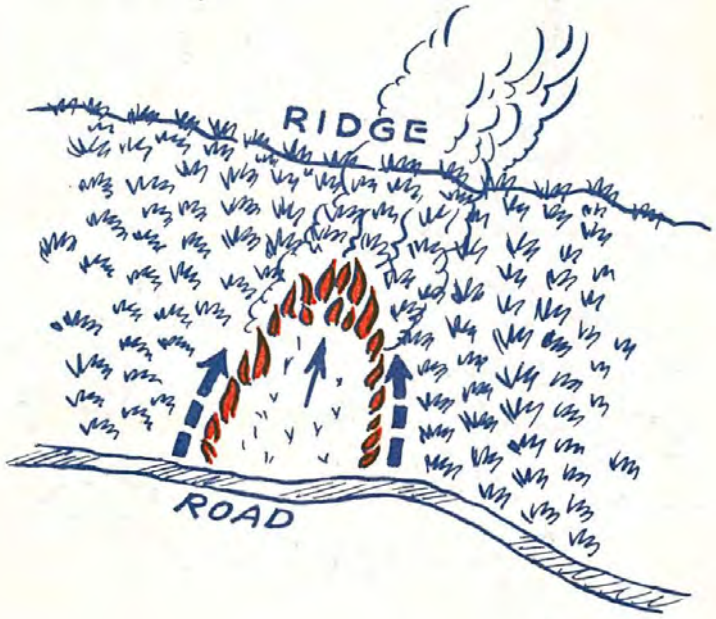
RESULTS

REDUCES SPOT FIRE DANGER, RATE OF SPREAD AND POSSIBLE LOSS OF LINE.

SPECIAL

IT IS USUALLY MOST IMPORTANT TO PREVENT CROWNING FIRST.

SMALL FIRE IN BRUSH OR REPRODUCTION BURNING UP HILL



CONDITION

TOO HOT FOR FRONTAL ATTACK.

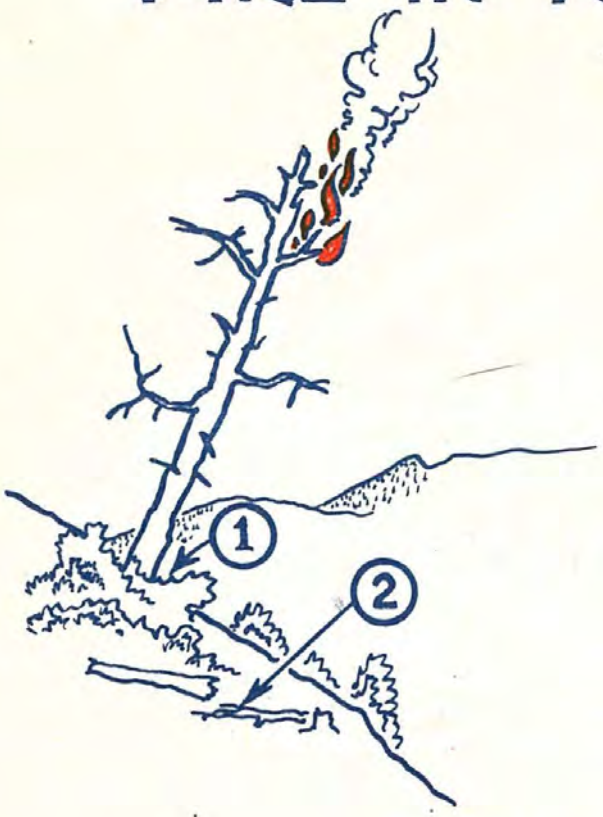
ATTACK

1. START WORK AT THE FLANKS FROM THE REAR.
2. TRAVEL THROUGH THE BURNED AREA TO THE HEAD AS SOON AS FIRE REACHES THE RIDGE TOP.

WHY

1. ACTION IS TAKEN ON THE REAR AND FLANKS TO CUT THE HEAT AND STOP THE LATERAL SPREAD.
2. FRONTAL ATTACK IS POSSIBLE WHEN HEAD OF FIRE REACHES RIDGE TOP. CATCH THE FIRE BEFORE IT GOES DOWN THE OTHER SIDE.

FIRE IN TOP OF SNAG



ATTACK

1. REMOVE FUEL AROUND BASE - DUFF, STICKS, GROWING BRUSH, ETC., FOR RADIUS LARGE ENOUGH TO CATCH FALLING LIMBS OR CHUNKS.
2. CLEAR OUT AREA, LENGTH BEING $1\frac{1}{4}$ TIMES HEIGHT OF SNAG.
3. FALL SNAG INTO CLEARING.

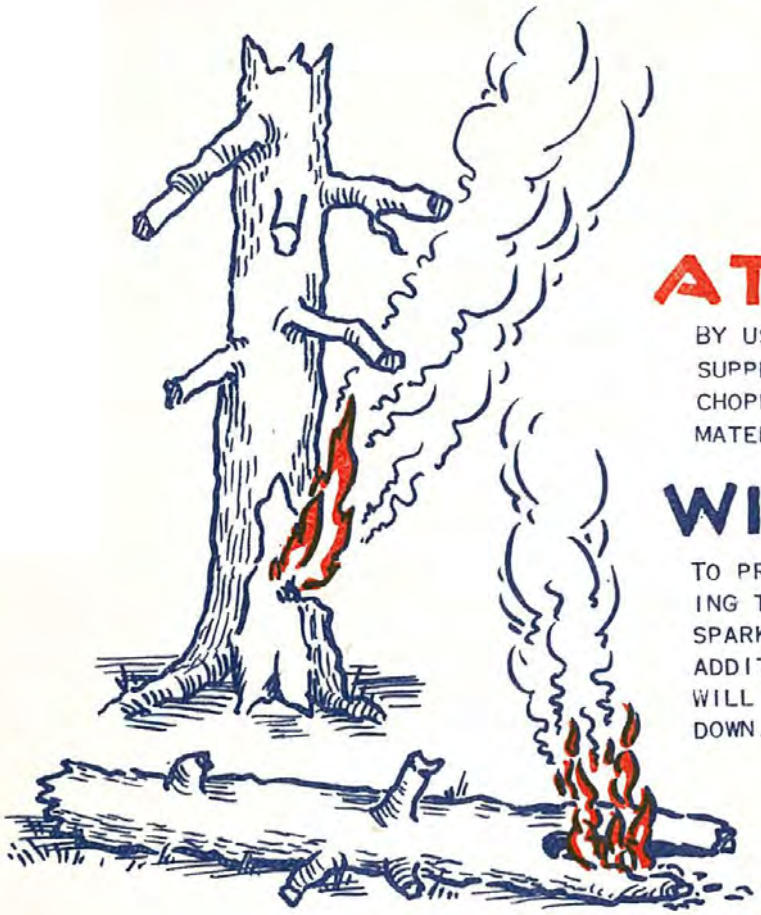
WHY

GET FIRE ON GROUND, WHERE IT CAN BE PUT OUT. ALSO PREVENT SPOT FIRES.

NOTE

IF TREE CANNOT BE FELLED, SAME CLEARING IS MADE TO RECEIVE CHUNKS AS THEY BURN OFF.

FIRE IN BASE OF SNAG



ATTACK

BY USE OF DIRT OR WATER, SUPPLEMENTED BY SCRAPING OR CHOPPING OUT BURNING MATERIAL.

WHY

TO PREVENT FIRE FROM CLIMBING TO TOP, SHOWERING SPARKS AROUND AND CAUSING ADDITIONAL SPOT FIRES. WILL SAVE CUTTING SNAG DOWN.

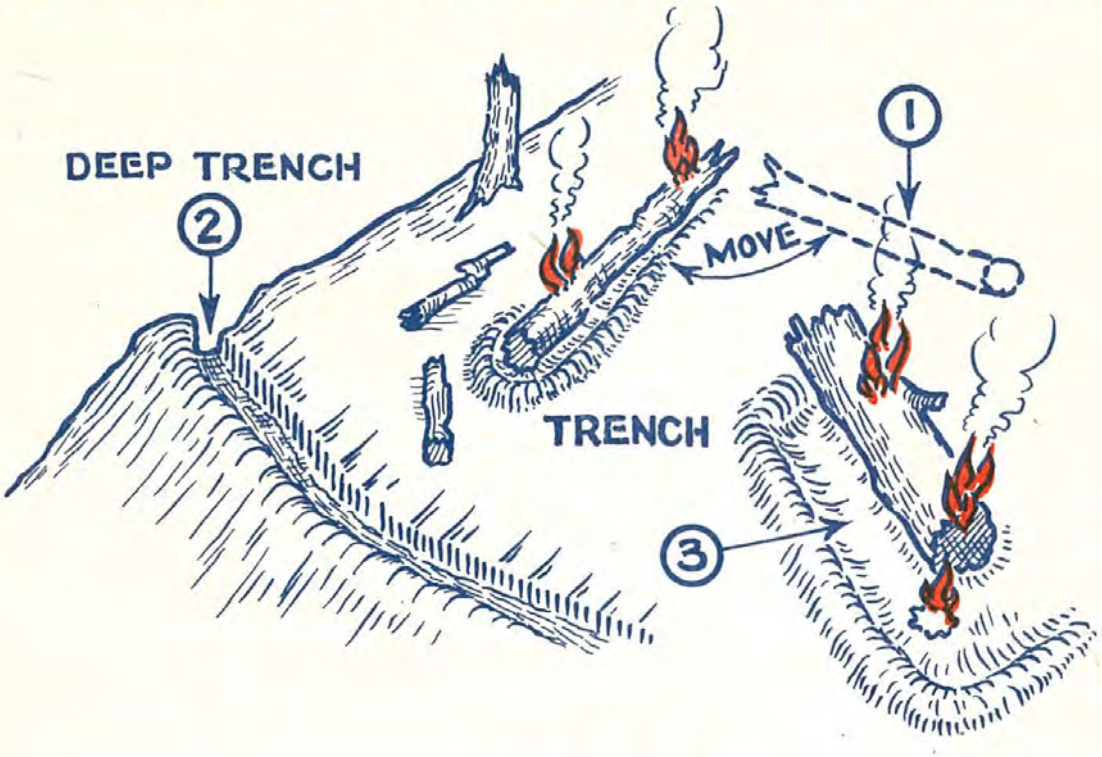
SAME ATTACK

FOR FIRES JUST STARTED IN DOWN LOGS.

MOP-UP

BURNING MATERIAL IS PLACED IN PIT AND MIXED WITH MINERAL SOIL.

CARE OF ROLLING MATERIAL



CONDITION

STEEP COUNTRY, DEEP SOIL, CONSIDERABLE MATERIAL THAT ROLLS READILY - PINE CONES, LOGS, ETC.

ATTACK

1. TURN LOGS AROUND TO LIE UP AND DOWN HILL, ROLL INTO PREPARED TRENCH AND COOL DOWN WITH DIRT AND SCRAPE.

2. CONSTRUCT DEEP TRENCH WELL BANKED WITH EARTH ON LOWER SIDE TO CATCH ROLLING CONES, ETC.

3. IF LOG IS TOO HEAVY TO HANDLE, DIG DEEP TRENCH BELOW IT.

SPECIAL

DO NOT BURY LOGS. THEY BURN THROUGH DIRT AND MAY THROW SPARKS OUT LATER, CAUSING SPOT FIRES.

C. T O O L S

Following is a list of the most common hand tools used in fire suppression work. If you live near timber, brush, or grass lands, you should become familiar with and keep on hand at least a cutting and scraping tool and a water container. The following tools are most commonly used:

1. A shovel
2. An axe
3. A Pulaski tool (combination axe-mattock)
4. A scraping tool - hoe, rake, McLeod, etc.
5. A good cross-cut saw - with sledge and wedges
6. A 4 or 5 gallon back pack pump

For the protection of your personal property you should have a back pack pump. Even if you have a pressure water system and hose in your home the pressure may fail, because of the fire, or the hose may not reach the desired distance.

Organized crews should have a tool for each man with extras to meet each situation. An average set-up for a five man crew is:

1. 2 axes or Pulaski tools
2. 3 scraping tools
3. 2 shovels
4. 2 back pack pumps
5. 1 cross-cut saw with sledge and wedges (in timber country)

Vary this according to the type of country: if largely timber you would probably want three axes instead of two, and only two scraping tools, etc.

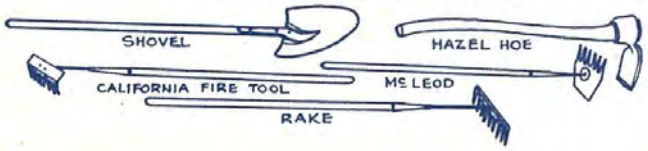
Be sure that you know where the tool caches are in your locality. Tool caches are put in strategic localities by the various protection agencies and lumber companies.

HAND TOOLS USED IN FIRE FIGHTING

CUTTING TOOLS

FALLING TOOLS

SCRAPING TOOLS



SWATTING TOOLS

WATER TOOLS

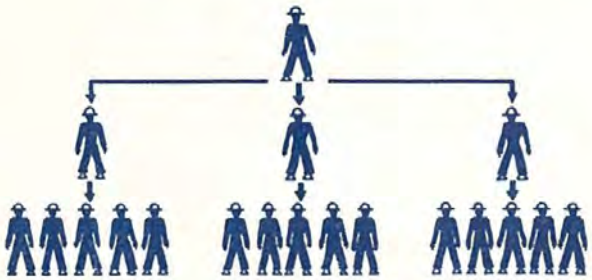
BACKFIRING TOOLS

D. FIRE LINE ORGANIZATION

As in every other line of endeavor firefighting requires organization. If you alone fight a fire you are the boss and firefighter combined. If you are a part of a volunteer fire crew you should make certain that the crew is organized to handle a fire effectively. If you are a part of an organized crew, be certain that you understand your place and duties in the crew. Know what is expected of you.

Example of crew organization:

A FIFTEEN MAN CREW



Fire Boss, if only crew on fire,
Crew Boss, if only 1 or 2 or more crews on fire

Straw Bosses

Crew men

Fifteen firefighters, broken into three groups of five each

Following the same pattern, a crew can be expanded or decreased, depending upon the need or the men available. This organizational scheme allows for close supervision.

On large fires the volunteer crew fits into the existing organization of the protection agency handling the fire, whether local, State, or Federal. The crew is concerned only with that portion of the fire to which it is assigned. The Crew Boss is responsible to the next higher supervisor, the sector or the Fire Boss, who is in charge of suppression activities for that part or all of the fire.

Definitions of Terms

Fire Suppression: The work of extinguishing a fire.

Wild Lands: Chiefly timber, range, watershed, and brush lands not under cultivation.

Wild Land Fire: A fire burning in any wild land area, such as a forest fire, range fire, brush fire, etc.

Fire Prevention: The activities concerned with reducing the number of fires started or preventing them from starting.

Dirt: Mineral soil or earth.

Fire Edge: The actual edge of the fire.

Fire Line: The strip which is scraped or dug to mineral soil.

Control Line: Constructed or natural barriers used in stopping a fire. This may include fire line when that is needed, the edge of grass fire that has been extinguished, road, lakes, bare rock, or other barriers used in controlling a fire.

Control a Fire: To surround a fire and any spot fires with control lines and eliminate unburned fuels inside the control lines.

Fire Boss: The man in charge of all operations on a fire.

Sector Boss: A man who is in charge of a specified section of the perimeter of a fire and who operates under direction of the Fire Boss.

Crew Boss: A man in charge of a group of fire fighters who operates under the direction of the Sector Boss.

Straw Boss: A working leader when designated and needed by the Crew Boss, in charge of from five to seven men.

Burning Out: The burning of intervening material between the fire edge and the fire line. This operation is usually done as line construction progresses.

Back Fire: A planned operation to burn out large areas between the fire edge and constructed line or natural barriers -- should be done under close supervision of experienced fire fighters.